

The genus *Drosera* L. (Droseraceae) in the western USA

Barry A. Rice

UC Davis Center for Plant Diversity, Plant Sciences M.S. 7, One Shields Avenue, Davis, CA 95616, USA
bamrice@ucdavis.edu

ABSTRACT

The genus *Drosera* is well known among botanists and naturalists because of its carnivorous habit. In the USA most *Drosera* species occur in the eastern states. Well-known native and introduced taxa in the western USA, treated and keyed in this paper, include *D. anglica*, *D. capensis* (introduced), *D. linearis*, *D. rotundifolia*, and *D. × obovata*. *Drosera × woodii*, a sterile hybrid observed from a limited population in Montana during the course of this study, represents a previously unreported taxon for the Pacific Northwest. *Drosera intermedia*, widespread in the Eastern USA, but unknown for the western states, is also discussed because of previous, incorrect reports of it in the region. Additional non-native *Drosera* species are included in the discussion as appropriate.

In the western USA *Drosera* populations are often widely separated. In some cases, isolated populations have been identified as potentially rare occurrences meriting particular conservation efforts. Populations of potentially rare *Drosera* in the western states were visited in the course of this study, to review their identifications. Published on-line www.phytologia.org *Phytologia* 101(1): 25-37 (March 21, 2019). ISSN 030319430.

KEY WORDS: *Drosera*, Droseraceae, western USA, carnivorous plants.

INTRODUCTION

The genus *Drosera* has more than 243 species worldwide (Lowrie *et al.* 2017), with 8 species currently recognized in North America (Rice *et al.* 2017). In the western states (MT, WY, CO, NM; and westward—that is, west of 105°W longitude) there are 3 species, mostly concentrated in the Pacific Northwest, and tending to occur in widely disjunct populations because of their restrictive habitat requirements. Populations occur from just a few meters above sea level to 2900 m. Because of site-to-site variations in habitat conditions, and possibly also because of genetic reasons, the phenotypic variation within a species can be significant. This has caused inconsistent identifications by field workers and taxonomists. In some cases, this has resulted in the (incorrect) reports of rare occurrences—this can and has resulted in conservation resources being applied to protect what were mistakenly thought to be rare elements (J. Costich-Thompson, L. Kinter, pers. comm. 2017). This paper serves as a comprehensive treatment of the genus in the western states to clarify these issues.

The native *Drosera* species of the western states are belong to the subgenus *Drosera*, section *Drosera* (Lowrie *et al.* 2017, Rice *et al.* 2017), which is a large but fairly natural group in the genus. The species in this region are restricted to full sun and perennially moist habitats (usually acidic or circumneutral pH) with low nutrient levels (Lowrie *et al.* 2017, Rice *et al.* 2017). Generally small perennials, they cannot survive long periods of inundation, nor can their weak root systems resist the rapid stream flows that may occur in riparian habitats during spring snowmelts. Gentle mountain seepages are ideal. The edges of lakes and ponds are suitable only if they maintain a constant water level. Floating vegetation mats (usually built upon a matrix based on *Sphagnum* or sedges) and floating, decaying logs are often excellent habitats.

In the eastern states, bogs and savannahs are often the preferred habitat of *Drosera*, but such habitats are rare in the west.

The yearly life cycle of all the native western *Drosera* species are similar. In the spring, the first leaves to emerge from the center of the rosettes tend to be small, and are not particularly helpful in identifying the species. Later leaves are larger and display species characteristics. The leaves are

petiolate, with long, sometimes flattened, mostly (but not always) glabrous petioles. The leaf blades are flattened, and the adaxial surfaces are covered with long, glandular hairs tipped with mucilage. At a distance, the plants can appear light green to deep red, and this overall color is due to contributions from leaf petiole, blade and the glandular tentacles. The degree of pigmentation is strongly affected by environmental effects (i.e., temporary inundation due to minor flooding, sun exposure, etc.), but occasionally very green populations may be encountered that may be governed by genetic factors (pers. obs.). Some populations can be so deeply red and extensive that they can be easily observed on satellite imagery.

Mature plants produce one or more inflorescences—erect, wiry, scorpioid racemes or weakly branching panicles. While flowering typically occurs in the spring, this depends on the site or even microsite; in sufficiently cold, harsh climates plants may be found flowering as late as September. Each day, one new flower opens in the morning, then closes by early afternoon. Little has been published about insects responsible for pollinating North American *Drosera* (Schnell 2002). Studying New Zealand *Drosera* species with similar floral and vegetative morphology, El-Sayad *et al.* (2016) observed pollination by a variety of *Diptera* (Syrphidae, Tachinidae, and Muscidae). Cultivated plants grown without the presence of pollinators also produce viable seed (pers. obs.).

Within several days after pollination, the fruit enlarge and if squeezed, will exude white, transparent immature seeds that can easily be seen with a hand lens. Mature seeds are black, grain-like, and have no apparent adaptations for dispersal, although their seed shapes and coats are distinctive and (at least in the western states) can be used to identify the species (Wynn, 1944). Hybrids occur in the western states, but these are sterile—after flowering, their fruit never enlarge, and instead remain slender.

Late in the season, leaves are produced that have petioles which are increasingly short and stout. The leaf blades are also reduced or absent entirely. In this manner, the plant transforms itself into a tight resting hibernaculum, by which the plant survives the winter cold and possible associated desiccation. Hibernacula of large plants are often multicrowned. In the spring, such multicrowned hibernacula often fragment, allowing for vegetative reproduction. This form of proliferation is the primary method of reproduction for sterile hybrids.

Seeds usually germinate in the spring, after a winter dormancy. Seedlings of all the species in our range are similar, and cannot reliably be distinguished. Often fruit do not fragment, but simply fall or are trampled into the soil—this can result in dense clusters of seedlings the following season.

For reference, the author maintains many carefully curated photographs of the taxa discussed in this paper, which can be reviewed at the CalPhotos web site (calphotos.berkeley.edu).

The carnivorous nature of *Drosera* is well established and described fully elsewhere (Lloyd 1942; Lowrie *et al.* 2017; Rice 2006; Schnell 2002; and others). Even so, it is remarkable, even to seasoned field scientists, how these organisms can capture surprisingly large prey such as dragonflies. This extraordinary behavior is also marvelously effective at capturing the interest of children, support by conservation donors, and enthusiasm by the general public.

Most of the *Drosera* species native to the USA are readily grown by the specialist, as long as their peculiar cultivation requirements are met (D'Amato 2013; Rice 2006). The primary cultivation challenge is associated with successfully providing an appropriate winter dormancy—during this period the winter hibernacula should be kept cold and moist. The length of the dormancy period, and the optimal temperatures, seems to depend upon the taxon and provenance, and can range from 3 to 7 months (pers. obs.). Most of these species are readily available from specialty nurseries, and in nearly all cases should not be field collected for cultivation.

The description above applies primarily to native species. Introduced exotics may differ, as noted in the discussions below.

The conservation status of *Drosera* in the western USA is currently fairly secure (Clarke *et al.* 2018). Most species occur over a wide range, and are often afforded a certain amount of protection as they are found in high quality wetlands (which have a suite of protective regulations). However, since they often occur in very small and isolated populations, they are prone to site-level extinction if there are significant changes in hydrology (either water flow or quality) or succession. Poaching is an annoyance, but *Drosera*

populations are usually limited by available habitat, and not reproductive potential—impact to sensitive habitat by trampling usually has more impact on populations than direct removal of plants.

METHODS

The following key uses a number of characters, so that plants even from aberrant populations can be confidently identified. It is best applied with mature, flowering or fruiting plants. Seedlings or young plants are not readily keyed out. Furthermore, even mature plants may not be readily identifiable early in the season as they emerge from hibernacula. While floral characteristics cannot be used to identify our native species, the seeds can be used definitively. In this key, the “leaf blade” is identified as the laterally expanded portion of the leaf that bears long, mucus-tipped glandular hairs; i.e., not including the non-glandular petiole. Seeds are easily found in immature and mature fruit, and can often even be found intact in fruit from previous seasons.

Specimens collected by the author (under permit, as appropriate) are stored at DAV.

Key to the *Drosera* in the western USA

1. Forming an erect stem; roots thick (diameter > 1 mm) and fleshy; inflorescence scape more than 1 mm in diameter and densely hairy; flowers large (> 15 mm across) with usually pale purple petals, rarely white; plants never forming tight winter resting buds.....*Drosera capensis* [Introduced exotic]
1. Leaves all from a basal rosette, forming an elongate stem only in extremely etiolated conditions; roots threadlike (diameter < 0.5 mm); inflorescence threadlike and less 0.5 mm in diameter and not hairy; flowers small (< 9 mm across) with white petals; plants produce tight hibernacula during the winter.
 2. Flowering-sized plants with leaf blades that are as wide, or wider, than long; leaves—except for the most recently produced—nearly all appressed against the ground in a flat rosette*Drosera rotundifolia*
 2. Flowering-sized plants with leaf blades that are longer than wide; leaves nearly all vertical or held at various angles, but mostly upwards.
 3. Leaf shape linear—leaf blade margins parallel over most of the leaf blade length; seeds rhomboidal, crateriform, 0.5-0.8 mm long; leaf blade length 5-8(20) × leaf blade width*Drosera linearis*
 3. Leaf shape short to long oblanceolate—leaf blade margins slowly widening from base for 2/3 or more of leaf blade length, then converging to blunt tip; seeds absent or if present, then fusiform, areolate-striate, 1-1.5 mm long; leaf blade length 1.3-5(15) × leaf blade width.
 4. In fruit, once approximately five flowers have opened, the lowest flowers will contain white to black grain-like seeds easily seen at 10×; leaf blade reaches maximum blade width approximately 2/3 the distance from blade base, then narrows to blunt tip; leaf blades generally more elongate than those of any *Drosera* hybrids present*Drosera anglica*
 4. Fruit never produce seed; leaf blade continuously widens along leaf blade length, reaching maximum width nearly at the blunt leaf tip; leaf blades generally less elongate than those of *D. anglica* or *D. linearis* (if either are present)Hybrids: *Drosera* × *obovata*, *D.* × *woodii*

As described in the DISCUSSION section below, *D. intermedia* has been incorrectly reported in extreme northern Idaho (Bursik 1993). This report has led to speculation it might occur elsewhere in the state. Reliable characteristics that can be used to separate *D. intermedia* from western USA species are given in the following key.

Key to *Drosera intermedia* vs. western USA *Drosera* species

1. Seed coat uniformly papillose; inflorescence emerges from the rosette center nearly horizontally, then arcs upwards to one side of the plant; flowering-sized plants with leaves held at various angles—from nearly straight up to horizontally, so that overall the plant occupies a hemispherical volume*Drosera intermedia*
1. Seed coat minutely rough or areolate-striate, or mature seeds absent; inflorescence emerges vertically (or nearly so) from the rosette center; flowering-sized plants with leaves that (except for the most recently produced) are nearly all appressed against the ground in a flat rosette (*D. rotundifolia*) OR the leaves on flowering-sized plants are held mostly vertically, so that overall the plant occupies a volume that is cylindrical, taller than wide (all other taxa)*Drosera anglica*, *D. linearis*, *D. rotundifolia*, *D. x obovata*, *D. x woodii*

DISCUSSION***Drosera rotundifolia* L.**

Key features: Flat rosette; leaf blades wider than long.

Western States reported: CA, OR, WA, MT, ID, only 4 verified sites in CO (Rice *et al.* 2017; Wolf *et al.* 2006).

Global range: A circumboreal species; outlying populations in the Philippines and New Guinea.

Habitats: Throughout its range, a surprisingly adaptable species. Open seepages—ranging from nearly level to steeply sloped—with little shading or competition are typical (Rice *et al.* 2017; Rice 2006; Schnell 2002). It can also be found in peculiar habitats such as floating *Sphagnum* mats or rotting logs, sheer rock surfaces covered with films of water, serpentinite soils (with *Darlingtonia californica*), and even geothermal fens (pers. obs.).

Comments: See Figure 1. Usually a relatively small species that may be only 3 cm across at flowering. In ideal situations, especially when extremely wet, plants can have much elongated petioles that result in a rangy, fragile architecture; such plants may be 10 cm across or more. Seeds are several times longer than wide, with acute tips, and longitudinally striate (see Figure 10).

This is the most abundant of the *Drosera* species in the western USA, occurring in the broadest range of habitats. However, it is perplexing that in large portions of the west, wetland habitats support *D. rotundifolia* and very rarely *D. anglica*, while in other portions of the west, the same habitats commonly support *D. anglica* and very rarely *D. rotundifolia*.

This species is easily cultivated by specialists.

***Drosera anglica* Huds.**

Key features: Vertically oriented leaves; leaf blades narrowly oblanceolate.

Western States reported: CA, OR, WA, MT, ID, WY, 1 site in CO (Rice *et al.* 2017; Wolf *et al.* 2006).

Global range: A circumboreal species.

Habitats: In California and Oregon, usually found only on *Sphagnum* mats and only rarely on open seepages. Elsewhere in the western USA it is more common in grassy or sedgy seepages, or on open flats of organic muck.

Comments: See Figures 2, 3. Quite variable in size and in leaf shape. In some regions (especially Idaho), the plant may be relatively prostrate and only 2-3 cm in diameter, with leaf blades only 1.3× longer than wide, encouraging misidentifications with *D. rotundifolia* (see also comments in *D. intermedia*, below). Hybrids between such small *D. anglica* with *D. rotundifolia* would be potentially very difficult to detect, unless particular attention were paid to infructescences (fertile: *D. anglica*, sterile: *D. × obovata*). In some locations (especially California), plants have extremely long, almost linear leaves that can be approximately 15× longer than wide. Even in such elongate specimens, the leaf blades slowly widen from the petiole width to the maximum leaf blade width as described in the key couplet #4.

Seeds are fusiform, and covered with tiny windows arranged in rows (see Figure 10).

It is widely believed that *D. anglica* originated long ago as a hybrid between *D. linearis* and *D. rotundifolia* (both $2N=20$). Indeed, in Michigan where the ranges of two parental species overlap in Michigan, the hybrid *D. linearis* \times *rotundifolia* (= *D. woodii*) has been detected, and is almost indistinguishable from *D. anglica*, except for being sterile. This hybrid is believed to have subsequently become fertile via a natural chromosome doubling event. The new, fertile entity spread from its point of origin throughout the northern hemisphere, as the highly successful modern species *D. anglica* ($2N = 40$) (Rice *et al.* 2017; Schnell 2002; Wood 1955).

This species is relatively easy to grow for specialist horticulturists, although it is rare for cultivated plants to be as large as may be observed in the wild. Specimens from populations marked by small, short leaved plants (Valley County, ID; Boundary County, ID), were grown side-by-side with specimens from populations with large, elongate leaves (Butte County, CA). Despite being grown by an expert horticulturist, the plants from the Idaho populations were comparatively difficult to maintain in cultivation, but pilot results suggest that they did maintain dwarfed characteristics in cultivation (Collingsworth, D., pers. comm. 2018, 2019).

***Drosera linearis* Goldie**

Key features: Vertically oriented leaves; leaf blades linear.

Western States reported: Three localized clusters of remote sites in MT (Rice *et al.* 2017; Montana Natural Heritage Program, pers. comm. 2017; Hitchcock & Cronquist, 2018). Reports of a population in Lake County, MT are erroneous—visits to the site have detected *D. rotundifolia*, but the site was otherwise inconsistent with *D. linearis* habitat (pers. obs.).

Global range: USA (MN, WI, MI, ME, MT), Canada (AB, ON, QC, NB, NL; possibly also BC, MB, NT, SK).

Habitats: Highly specialized, occurring in the muck on floating sedge-dominated vegetation mats or lake margins. In the western USA, only in remote mountain fens.

Comments: See Figure 4. This plant can bear a superficial resemblance to very long-leaved strains of *D. anglica*, but can reliably be distinguished by leaf blade outline, or seed characters, as noted in the key.

This species is primarily found in the Great Lakes area, and eastward. The Montana populations are remarkably remote. However, a few sites are also found to the north in British Columbia (Jenifer Penny, pers. comm. 2016), Manitoba (Chris Friesen, pers. comm. 2016), and Saskatchewan (Beryl Wait, pers. comm. 2016). Broadly speaking, these bridge the Montana plants to the eastern populations.

This species is extremely difficult to cultivate, even for experts (D'Amato 2013), and cultivated plants usually perish after a few years. While horticulturists have been known to introduce carnivorous plants to sites outside their native ranges (see below), it is extremely unlikely that the plants in Montana represent artificially introduced plants. The sites are remote—some taking days of pack travel to reach—in habitat frequented by grizzly and black bears. Meanwhile, locations targeted by people attempting introduction experiments are typically roadside or otherwise easily accessible.

***Drosera* \times *obovata* Mert. & Koch (= *D. rotundifolia* \times *anglica*)**

Key features: Vertically oriented leaves; leaf blades obovate; fruit always sterile.

Western States reported: CA, OR, 1 site in WA (Rice *et al.* 2017; WTU specimen 314866; Hitchcock & Cronquist, 2018).

Global range: Sporadically detected wherever both parent species are found near each other.

Habitats: Usually *Sphagnum* dominated flats, occasionally other wet seepages.

Comments: See Figure 5. To be expected whenever the parent species *D. anglica* and *D. rotundifolia* occur in close proximity, but occasionally found at sites with one of the parent species absent. (Why one of the parents may be absent is not known—either a pollinator may have introduced pollen of the absent species, or some stress may have resulted in the local extinction of one of the parent species.) *D.* \times *obovata* may occur (as yet undetected) in ID and MT, and possibly even CO.

Late season plants can easily be distinguished from *D. anglica* by the lack of seeds. In *D.* \times *obovata*, the old, dried flowers are slender and lack seeds; in *D. anglica*, the fruit develop soft white, then hard

black seeds within a week of flowering—these seeds are retained in the fruit throughout the rest of the growing season.

This hybrid generally has leaf characteristics intermediate between the parent species. In California and Oregon sites, where the parent *D. anglica* may have extremely long leaves, *D. × obovata* can have leaf blades 3-3.5 × longer than wide. In regions where the parent *D. anglica* has much shorter leaves (such as Idaho), *D. × obovata* might only be reliably detectable by the lack of seeds. This suggests that *D. × obovata* is probably generated locally, and does not spread readily. This is understandable for a hybrid plant that only propagates itself vegetatively. However, this could be explored in greater detail in common greenhouse cultivation.

Drosera × obovata is easily grown by horticulturists. Extremely large specimens from Butte County, CA that were collected in the course of the research for this study, were grown in cultivation and retained their oversized attributes (Collingsworth, pers. comm. 2018, 2019).

***Drosera × woodii* Gauthier & Gervais (= *D. rotundifolia* × *linearis*)**

Key features: Vertically oriented leaves; leaf blades obovate; fruit always sterile.

Western States reported: 1 site in MT.

Global range: Known only from MI and MT.

Habitats: In the western USA, known from only one sedge-dominated fen; only in the muck on detached, floating vegetation mats.

Comments: See Figures 6, 7. During the course of research leading to this paper, a Montana site reportedly supporting *D. linearis* and *D. anglica* was investigated. While the *D. linearis* was verified, the “*D. anglica*” was found to be a heterogenous population of short and long leaved, sterile hybrids. Collections of this population made in 1985 (MONTU 102206, 102480) were incorrectly identified as *D. anglica*. This is the first report of (putative) *D. × woodii* from the western USA.

The identity of the short-leaved and long-leaved hybrid populations cannot be determined with complete certainty. *Drosera linearis* is present and is probably one of the parent plants. True *D. anglica* was not found at the site. *Drosera rotundifolia* was reported in the immediate area in 2004 (Montana Natural Heritage, 2017), but no herbarium collections were made. *Drosera rotundifolia* was not found on two visits in 2017 conducted during the course of this study. It is possible that the reports of *D. rotundifolia* are due to observations of short-leaved hybrid individuals. The morphology of the hybrids, especially plants in the short-leaved population, strongly suggest one of the parent plants was *D. rotundifolia*. In this paper I tentatively conclude that the two hybrid populations are best treated as *D. × woodii*. It seems unlikely, but it is possible the hybrid plants are actually *D. linearis* × *anglica* (= *D. × linglica* Kusakabe ex Gauthier & Gervais).

Both *D. × woodii* and *D. × linglica* have been found only in Michigan (Schnell 2002) and Quebec (Brouillet *et. al.*, 2010). In Michigan, they only occur at sites where both parent species are found (Schnell 2002). The presence of *D. × woodii*, in two populations (both short-leaved and long-leaved plants) is a double-rarity for this extremely interesting site.

A complete census of the site was not conducted, however rapid visual assessments indicated that the population of both short-leaved and long-leaved plants ranged from several hundred, to thousands, or even more. Based upon horticultural experience with sterile *Drosera* hybrids, these plants probably proliferate by the production of secondary, lateral hibernacula in dormancy (which can easily detach).

This hybrid is not in cultivation, and as such the site is subject to potential conservation impacts from collection. However, this site is large enough, and so remote, that casual visitation is unlikely to cause significant damage. Repeat visitation is more likely to cause significant trampling damage, and such impacts should be taken into consideration if any research plans are proposed.

***Drosera capensis* L.**

Key features: Stem-forming, roots thick (diameter > 1 mm) and fleshy, inflorescence scape thick (diameter > 1 mm) and densely hairy; flowers large and usually lilac to purple.

Western States reported: CA: Mendocino County, Del Norte County (Rice 2002; pers. obs.).

Global range: Native to South Africa, but may be encountered elsewhere as a non-native species introduced by horticulturists.

Habitats: Wet seepages.

Comments: See Figure 8. This commonly cultivated African species (Robinson *et al.* 2017) is the most frequently encountered non-native *Drosera* in the western USA. Plants less than a year old are similar in form to young *D. anglica* or *D. linearis*, although the subsucculent roots are much thicker than the fibrous roots of the native species. The flowers are usually pink to purple (very rarely white), and are on thick, hairy inflorescences. Hibernacula are not produced.

In Mendocino County (CA), *D. capensis* is certainly an intractable weed at one site (Rice 2002). It is occasionally encountered in Del Norte County (CA), where horticulturists have repeatedly introduced plants into *Darlingtonia* seepages (pers. obs.). This is the origin of reports of *D. linearis* in Del Norte County (Stone 1993).

Plants are usually top-killed by freezing conditions, but can readily regenerate from seeds or root systems. Populations are likely to be detected in coastal OR, WA, and BC (Canada).

***Drosera intermedia* Hayne**

Key features: Leaves oriented so as to describe a spherical volume; scape horizontal at base; seed coat papillose.

Western States reported: ID (Bursik 1993), but incorrectly.

Global range: Europe; eastern Canada; eastern half of USA, south to northern South America.

Habitats: Wet seepages.

Comments: See Figures 9, 10. *Drosera intermedia* is a species with wide distribution in eastern North America, and globally in Latin America and Europe (Rice 2006). Its supposed presence in Idaho dates to reports by Bursik (1993). In this paper, Bursik noted the presence of *D. intermedia* in Smith Creek RNA (Boundary County, ID). This promulgated additional reports in the Sawtooth Mountains in Custer County, ID (L. Kinter, pers. comm. 2017). As part of this study, Smith Creek RNA was surveyed, and the purported “*D. intermedia*” plants were refound. Their growth forms, leaf and seed characteristics were all consistent with *D. anglica*. The plants at this site have an interesting clustering character, but are otherwise typical. Plants from these sites have proven to be surprisingly difficult to grow in greenhouse cultivation, even by expert horticulturists (Collingsworth, pers. comm. 2018, 2019). It is still not clear if the interesting, clumping character is genetic or is due to environmental conditions. The Custer County, ID sites were also surveyed, and the plants there were similar entirely consistent with *D. anglica*.

The papillose seed coats of *D. intermedia* are diagnostic, and visible at 10× (see Figure 10). None of the plants in the western USA had such seeds.

There is no remaining evidence for native *D. intermedia* in the western USA. However, skeptical field workers finding suspected “*D. intermedia*” should examine the “Key to *Drosera intermedia* vs. western USA *Drosera* species,” given above.

Exotic *Drosera* species of extremely limited range

Carnivorous plant horticulturists have had a long and unfortunate interest in planting non-native carnivorous plants in the wild. In Mendocino County (CA), horticulturists have been introducing non-native carnivorous plants from many genera to a wildland location owned by The Nature Conservancy. Despite Conservancy staff attempts to stop this activity by outreach to horticulturists, and by some removal activity, more than twenty non-native carnivorous plant taxa have been found on the site (Rice 2002). In addition to *D. capensis*, *Drosera* observed at this site include *D. aliciae*, *D. binata*, *D. burmanni*, *D. capillaris*, *D. filiformis*, *D. intermedia*, *D. slackii*, and others (pers. obs.).

Another plant—probably *D. × hybrida* Macf., but possibly an allied hybrid—has been detected at Butterfly Valley Botanical Area (Plumas County, CA), and after a few years of work has been extirpated (Rice 2005). This is the origin of reports of *D. anglica* in the Butterfly Valley watershed, as recorded in unpublished US Forest Service plant lists for the region (ca. 1992).

ACKNOWLEDGEMENTS

The author would like to thank John Brittnacher, Braden Burkholder (Montana Natural Heritage Program), Damon Collingsworth (California Carnivores), Jennifer Costich-Thompson (US Forest Service), Justina Dumont (US Forest Service), Lynn Kinter (Idaho Natural Heritage Program), Ben Legler (University of Washington Herbarium), Andrea Pipp (Montana Natural Heritage Program), Elizabeth Salvia, Steve Shelly (US Forest Service), Debarah Taylor (US Forest Service), and Ellen Dean and other staff at the University of California (Davis) Center for Plant Diversity. Referees to this paper (Daniel McNair, Bob Ziemer, Fernando Rivadavia) provided many useful comments that improved this manuscript.

LITERATURE CITED

- Brouillet, L., F. Coursol, S. J. Meades, M. Favreau, M. Anions, P. Bélisle and P. Desmet. 2010+. VASCAN, the Database of Vascular Plants of Canada. <http://data.canadensys.net/vascan/> (consulted on 2018-01-15).
- Bursik, R. J. 1993. Fen vegetation and rare plant population monitoring in Cow Creek Meadows and Smith Creek Research Natural Area, Selkirk Mountains, Idaho. Idaho Dept. of Fish and Game.
- Clarke, C., A. Cross and B. Rice. 2018. Conservation of carnivorous plants, In: Carnivorous plants: physiology, ecology, and evolution, Ed. Ellison, A., and L. Adamec, Oxford University Press, Oxford, United Kingdom.
- D'Amato, P. 2013. The Savage Garden (revised): cultivating carnivorous plants. Ten Speed Press, Berkeley, California.
- El-Sayed, A. M., J. A. Byers and D. M. Suckling. 2016. Pollinator-prey conflicts in carnivorous plants: When flower and trap properties mean life or death. *Sci. Rep.* 6, 21065; doi: 10.1038/srep21065.
- Hitchcock, C. L., and A. Cronquist. 2018. Flora of the Pacific Northwest: An Illustrated Manual. 2nd edition. D.E. Giblin *et al.*, eds. University of Washington Press, Seattle.
- Lloyd, F. E. 1942. The Carnivorous Plants. *Chronica Botanica*, New York.
- Lowrie, A., R. Nunn, A. Robinson, G. Bourke, S. McPherson and A. Fleischmann. 2017. *Drosera* of the World, Vol. 1: Oceania. Redfern Natural History Productions, Poole, Dorset, England.
- Rice, B. A. 2002. *Drosera aliciae*, *D. capensis*, and *Utricularia subulata* in California (Noteworthy Collections), Madroño. 193-194.
- Rice, B. A. 2005. *Drosera* × *hybrida* in California (Noteworthy Collections), Madroño. 271.
- Rice, B. A. 2006. Growing Carnivorous Plants. Timber Press: Portland.
- Rice, B. A., A. Robinson and A. Fleischmann. 2017. *Drosera* of North America. In: *Drosera* of the World, Vol. 2: Oceania, Asia, Europe, North America. Lowrie *et al.* eds., Redfern Natural History Productions, Poole, Dorset, England.
- Robinson, A., R. Gibson, P. Gonella, S. McPherson, R. Nunn and A. Fleischmann. 2017. *Drosera* of the World, Vol. 3: Latin America & Africa, Redfern Natural History Productions, Poole, Dorset, England.
- Schnell, D. E. 2002. Carnivorous Plants of the United States and Canada. (2nd Edition). Timber Press, Portland.
- Stone, W. J. 1993. Droseraceae. In: J. C. Hickman (ed), The Jepson Manual: Higher Plants of California. University of California Press, Berkeley, California.
- Wolf, E., E. Gage and D. J. Cooper. 2006. *Drosera rotundifolia* L. (roundleaf sundew): a technical conservation assessment. USDA Forest Service, Rocky Mountain Region.
- Wynn, F. E. 1944. *Drosera* in eastern North America. *Bull. of the Torrey Bot. Club.* 71: 166-174.



Figure 1: *Drosera rotundifolia*. Plants as typically seen (Tehama County, California). Note the ground-hugging habit, and leaves with glandular blades wider than long. Additional images can be seen at <https://calphotos.berkeley.edu/> by selecting “Scientific Name EQUALS” *Drosera rotundifolia*, and “Photographer EQUALS” Barry Rice.



Figure 2: *Drosera anglica*. Various forms of this plant—Top-left: long-leaved plants (Plumas County, California); Top-right: typical, medium-leaved plants (Butte County, California); Bottom-left: short-leaved plants (Valley County, Idaho); Bottom-right: very green plants (Custer County, Idaho). Additional images can be seen at <https://calphotos.berkeley.edu/> by selecting “Scientific Name EQUALS” *Drosera anglica*, and “Photographer EQUALS” Barry Rice.



Figure 3: *Drosera anglica*. Short-leaved, clumping plants that have been incorrectly identified as *D. intermedia* (Boundary County, Idaho).



Figure 4: *Drosera linearis*. Typical plants (Lewis and Clark County, Montana). Note how the margins of the leaf blades are parallel over much of their lengths. Additional images can be seen at <https://calphotos.berkeley.edu/> by selecting “Scientific Name EQUALS” *Drosera linearis*, and “Photographer EQUALS” Barry Rice.



Figure 5: *Drosera x obovata*. Plants with very typical leaf shape (Butte County, California). Additional images can be seen at <https://calphotos.berkeley.edu/> by selecting “Scientific Name EQUALS” *Drosera x obovata*, and “Photographer EQUALS” Barry Rice.



Figure 6: *Drosera x woodii*. The long-leaved form of this plant is at center and left, while *Drosera linearis* is at right (Lewis and Clark County, Montana). Notice the slender seedpods on the tall inflorescences of the sterile hybrid, in contrast with the plump seedpods on the short inflorescences of *Drosera linearis* visible here and in Figure 4.



Figure 7: *Drosera x woodii*. The short-leaved form of this plant (Lewis and Clark County, Montana). The overall plant morphology is strongly suggestive of a *Drosera rotundifolia* parentage.



Figure 8: *Drosera capensis*. The morphology of the leaf-blade is similar to *Drosera linearis* (Del Norte County, California). *Drosera rotundifolia* is also visible in the rear left. Additional images can be seen at <https://calphotos.berkeley.edu/> by selecting “Scientific Name EQUALS” *Drosera capensis*, and “Photographer EQUALS” Barry Rice.



Figure 9: *Drosera intermedia*. Comparison images for this species, which is not found in the western USA—Left: notice how the scape emerges from the rosette nearly horizontally, then curves upwards (Left: Pender County, North Carolina); Right: a stem-forming individual (Columbus County, North Carolina). Notice that in both plants, leaves are held at a variety of angles, so the upper portion of the plant occupies a hemispherical region. Additional images can be seen at <https://calphotos.berkeley.edu/> by selecting “Scientific Name EQUALS” *Drosera intermedia*, and “Photographer EQUALS” Barry Rice.



Figure 10: Seed coats of *D. anglica*, *D. rotundifolia*, and *D. intermedia*, photographed on a 1 mm grid. Note the papillose seed coats of *D. intermedia*. The seeds of *D. linearis* are not shown, but do not bear papillae. Seed photographs provided by John Brittnacher.